Perodua Eco-Challenge 2010: Ideas of Modification from ARG UTHM

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Abstract:

This paper discusses the Universiti Tun Hussein Onn Malaysia (UTHM), Automotive Research Group (ARG) entry to the Perodua Eco-Challenge 2010. Included in this report are the modifications aspect proposed for the competition that consists of exhaust system, combustion system, aerodynamics and fuel delivery system in order to increase fuel economy.

1. Introduction

The Perodua Sdn. Bhd (Perodua) which is known as a second national manufacturer car organized the Perodua Eco-Challenge 2010 (PEC2010) in response to the overwhelming success of the same program in year 2009. The purpose of this program is to promote and challenge the engineering capabilities among engineering students through modification of the vehicle which lead to lower fuel consumption without sacrificing the environment. Instead of donating Perodua Myvi, like last year, each eligible participating institution are given an unregistered Perodua Viva for which students had the opportunity to modify the vehicle in order to improve the fuel efficiency and at the same time maintaining or lowering exhaust emissions.

To be selected in this competition, each institutional of higher learning need to submit their ideas of modification proposal and based on 23 applications, Universiti Tun Hussein Onn Malaysia (UTHM) was one of twelve institutional approved by Perodua for the 2010 competition. The competition was conducted on 26 June 2010 at Melaka International Motorsport Circuit (MIMC), Ayer Keroh.

With the focus of promoting fuel economy, there are two categories in this competition: manual transmission and automatic transmission. Winning are based on maximum travelling distance that was achieved by using one liter of Petronas RON 95 petrol with the least amount of penalties for each category.

In other to modify the car, Perodua provided RM10,000.00 for each institutional as a development fund.

2. Ideas of Modification

In an effort to design and modify the car for the competition, UTHM with the commitment of the students and lecturers (figure 1) had came out with some ideas of modification that promote fuel savings and reduced emissions.

Figure 1: UTHM Team PEC2010

The ideas of modification with the expected benefits are discussed in the following sections.

2.1 Variable Twin Exhaust System

Modification to the exhaust system focused on two primary areas; performance and emissions. The best of low RPM, low-end torque and better top-end power can be achieved by routing the exhaust gas through different stages of the exhaust system. This will result in the best engine and fuel efficiency.

The variable twin exhaust system (VTES) consists of two different lengths of exhaust pipes that split approximately 0.5m from the exhaust ports as shown in figure 2.

The novelty of this system lies in the control mechanism that enables routing the exhaust gas through different pipe lengths, in order to achieve the best engine efficiency.

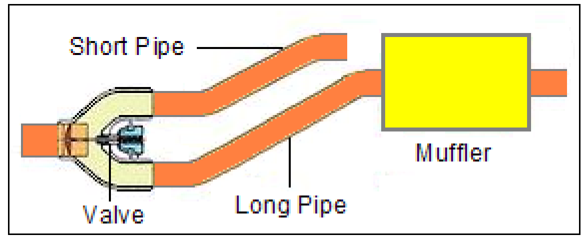

Figure 2: Variable twin exhaust system, with one of the pipes longer than the other

The fuel efficiency of an internal combustion engine correlates highly with the amount of torque it produces; high torque corresponds to high efficiency. Figure 4 shows the torque curve of a test engine with a standard exhaust pipe, compared to another curve for the same engine with the exhaust pipe replaced by a shorter one. The torque produced by the engine at low speeds is higher when using the standard, longer pipe. However, when the engine speed reaches a certain threshold, the engine could produce a higher torque using the shorter pipe. Therefore, the engine torque can be maximized by using the VTES where the exhaust gas can be routed to either of the pipes according to the engine speed.

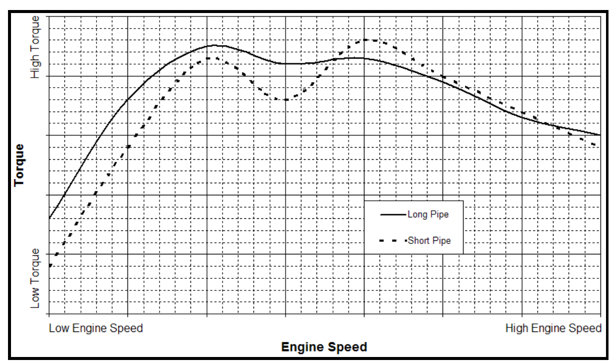

Figure 5: Torque produced by a test engine for the different exhaust configuration [1].

2.2 Greenometer©

Greenometer© is a fuel-consumption gauge that is invented to improve fuel consumption by controlling the fuel and air flow rate. It can prolong the life span of the engine and aid the driver in adapting to an economic driving style. The device will be used to promote '*green*' driving habits, by providing real time fuel economy.

Greenometer© can promote "*green*" driving style by active involvement from the driver. The **Greenometer**© will monitor various engine parameters and sends useful feedback to the driver.

2.3 Swirled Mixing System (SMS)

In order to improve the combustion mixture, the profile of the piston crown will be modified to promote turbulence mixing [2].

Figure 3 has shown that the flow of combustion mixture in the combustion chamber without swirl effect on the left, whilst flow with induced swirl is shown on the right.

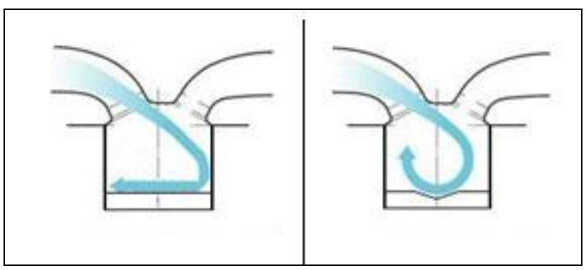

Figure 3: Flow of combustion mixture in the combustion chamber

It is known that the efficiency of combustion depends on the condition of the pre-combustion air-fuel mixture. The SMS enhances the homogeneity of the air-fuel mixture prior to combustion by inducing swirled flows to increase burning intensity through enhanced mixing and thus lower residence time.

This system promises to reduce emission while achieving good thermal efficiency [3].

2.4 Aerodynamic Panels

Aerodynamic enhancing devices will be installed to control the airflow around the vehicle as a means to reduce friction drag.

This device will control the airflow around the vehicle to reduce aerodynamic drag as well as to aid cooling of components and cabin. The source of drag may come from rough surfaces on the vehicle, thus several panels will be installed to reduce the form and friction drag of the vehicle. The designs of these panels are done through extensive experimental and computational works [4].

Figure 6: Aerodynamic panel on the bottom of the rear vehicle.

Taking into account the weather condition during the event which will likely be extremely hot and humid, it is necessary that some cooling is provided to the driver. This can be done by having air intakes to cool the cabin with minimum drag penalty.

2.5 Parasitic Load

Parts and components that are not critical will be removed to reduce the total car mass. Removal of unnecessary parts include: air-condition compressor and piping, alternator, remove or change seat, and radio.

Fuel efficiency is inversely proportional to vehicle mass. So, by reducing engine load, the vehicle fuel efficiency can be improved.

2.6 Fuel Tank

The standard fuel tank with capacity of 50 liter had been removed and a new fuel tank that just can be filled with one liter petrol only was designed and fabricated.

The new designed fuel tank is shown in the figure 4 below.

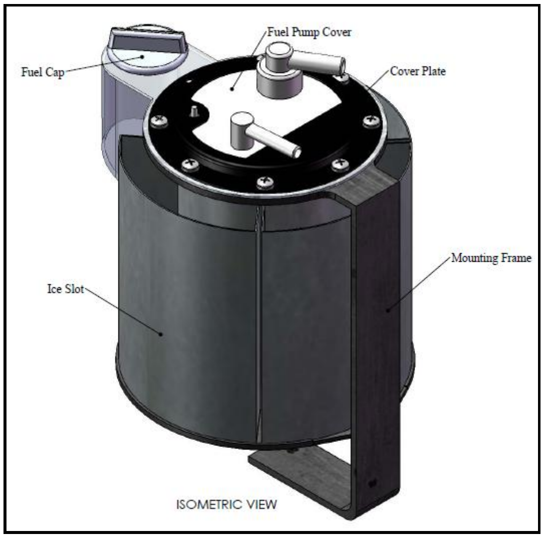

Figure 4: New design of fuel tank

With the new fuel tank, fuel that has been delivered to the combustion chamber and was not consumed will return to the fuel tank via a return line. The quantity of fuel flowing back through the return line is depending on the engine operation. By enabling fuel to return to the fuel tank, the tank assisted in reducing fuel waste.

3. Outcomes from the competition

I. Viva UTHM accumulated 28.8 km/liter.
II. The most influential modifications:
   a. *Greenometer*©
   b. Aerodynamic Panels
   c. Parasitic Load
III. In general, the modified car achieved the competition's main objective, which is to increase the travelling distance for one liter of fuel.

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